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SPECIAL ISSUE

Coastal Management

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Participation and integration are key to coastal management

The increasing man-made impacts and effects of climate change are making our coastlines more vulnerable to coastal risks including erosion and flooding. These impacts are far-reaching and are already changing the lives and livelihoods of coastal communities. In addition, they could further threaten valuable ecosystems and damage industries, such as fishing, tourism and shipping.

We need to better understand the ongoing processes in this complex and sensitive system of nature-human interactions and to reduce the negative impacts of coastal change. To achieve this we must draw on research expertise, not only from natural sciences and engineering, but also increasingly and pressingly from social sciences and economics, with clear and effective stakeholder engagement to develop participatory and integrated policies. This thematic issue reports on recent research from across all these fields to help guide successful coastal management.

Effective participation of all stakeholders is needed to create fair decision-making processes in integrated coastal flood risk management. This issue is explored in 'Participatory approach needed to tackle coastal flooding', a case-study from the Thames Estuary in the UK. The study calls for cross-sectoral approaches to coastal development and to consider all public and stakeholder views, at local, regional and national scales. The article 'Practical applications of resilience principles for coastal communities' provides advice on building resilience into management strategies to help our coasts cope under climate change.

Besides housing a number of important industries, our coastal areas provide a number of ecosystem services and resources, which also provide powerful economic arguments for the protection of our coasts. The growing understanding of the economic contribution of the coast is considered in 'Putting a price on the Catalan coastal ecosystems' and 'Time to take stock of marine and coastal assets'.

The future for our coasts is complex, climate change dependent and holds many uncertainties. Long-term, strategic approaches are therefore needed in coastal governance. The article 'Large-scale coastal management more sustainable in the long-term' draws lessons from the Netherlands' experience of coastal defence. It suggests new management strategies as small-scale management does not produce the best results in the long-term.

Modern technologies increasingly ease the task of integrating all the complex elements of our coastlines for better decision making. The article 'Geographic Information Systems help manage coastal areas' describes how GIS is supporting Integrated Coastal Zone Management (ICZM) in Spain.

Participatory and integrated coastal governance is multi-scalar and works across boundaries (research, professional, sectoral and administrative boundaries). It is key to coastal management, whether dealing with sustainable use of resources and specific types of coastal zones, or adapting to risks and climate change. Further research and development of governance activities are needed around issues such as institutions, coordination mechanisms and management regimes for ICZM, and, particularly, communication activities. Coastal information, education/training, participation, public and stakeholder involvement in decision-making processes and management leads to behavioural change in all coastal stakeholders.

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Integrated approach needed to tackle coastal flooding

A new study outlines the challenges faced in securing Europe's coastlines against flood damage. The study highlights the importance of taking an integrated approach to coastal management which accounts for scientific, socio-economic and political factors, and considers the problem at local, regional and national levels, from the perspectives of all stakeholders.

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"The researchers argue that the value of stakeholder engagement is in creating a fair decision-making process, rather than leading automatically to better quality decisions that emerge from the process."

Coastlines are important not only to those who live there or those who visit them as holiday destinations, but also to the fishing industry and for international trade. Much of Europe's coastline is under threat from erosion and flooding, which will only be exacerbated by rising sea levels caused by global warming.

The EU Directive on the Assessment and Management of Flood risks[1] requires Member States to assess the risk of coastal flooding, to map the flood extent and assets and humans at risk in these areas, and to reduce the risk. Flood risk management favours an integrated and cross-sectoral approach, for which the principles of the EU Integrated Coastal Zone Management (ICZM) Recommendation can be used. Under the EU ICZM Recommendation regulation, national strategies are being developed that aim to protect European coastlines based on a cross-sectoral and participative approach.

The new study takes the Thames Estuary in the UK as a case study to explore different stakeholder perspectives on the concept of integrated coastal flood risk management. The authors of the study carried out in-depth interviews with six different stakeholders – ranging from a regional planning body and an association representing the UK's insurance industry, to charities and trusts involved in supporting the management of the estuary.

These perspectives were analysed to identify potential barriers and enabling factors in implementing an effective coastal flood risk management strategy. The findings reinforce the view that integration is key to managing the coastal environment into the next century.

The researchers found there was little incentive to develop new approaches to flood risk management, as money had already been invested in existing flood defence infrastructure and continues to be required for hard protective defences. Existing models of spatial development planning were also found to prevent progress. A new push towards more innovative solutions is needed that incorporates not just flood defences, but also strategic flood risk management approaches.

Another challenge for integration is overcoming resistance to participatory approaches to engaging with stakeholders. The interviewees were not clear about the reasons for engagement and there was also evidence of conflict between 'strong government' and participatory management. The researchers argue that the value of stakeholder engagement is in creating a fair decision-making process, rather than leading automatically to better quality decisions that emerge from the process. The findings demonstrate the need to address the complexities of the diverse interests and perspectives of stakeholder groups.

Source: McFadden, L., Penning- Rowsell, E., and Tapsell, S. (2009). Strategic coastal flood-risk management in practice: Actor's perspectives on the integration of flood risk management in London and the Thames Estuary. *Ocean & Coastal Management.* 52(12): 636-645.

1. See http://ec.europa.eu/environment/water/flood_risk/index.htm

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Practical applications of resilience principles for coastal communities

Adapting to climate change in coastal cities needs further development of the resilience approach as well as identifying how it can be practically used in local actions, according to a new study. The researchers present resilience as a flexible, practical way of dealing with climate change's impacts, such as coastal flooding, which can be easily built into adaptation measures.

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"The resilience principle of 'homeostasis', which looks to stabilise a system and limit impacts, could be realised through early warning systems and urban planning to reduce flood damage."

Resilience is a term often used in ecology to mean the ability of an ecosystem to withstand change or bounce back after a particular shock. It can also be used in a societal or socio-ecological sense to mean the ability of a particular population and its environment to undergo change or shocks without collapsing into an undesired state. In terms of climate change these could be relatively slow changes, as in sea level rise, or sudden shocks, as in flooding.

The researchers involved local practitioners and scientists in interviews and a workshop to try to develop measures for adapting to climate change in the coastal city of Rotterdam, Netherlands. The participants identified practical ways in which they could build six principles of resilience into local actions.

For example, the resilience principle of 'homeostasis', which looks to stabilise a system and limit impacts, could be realised through early warning systems and urban planning to reduce flood damage. The principle of 'omnivory' uses several different approaches in case one fails. One way of incorporating this into local actions, as suggested by the participants, is to use several different types of energy supply in case one is suddenly cut.

The 'high flux' (quick turnover of resources) principle could be translated into adaptation actions by constructing cities so they can be easily rebuilt, for instance. The 'flatness' principle seeks to avoid unnecessary bureaucracy. The participants said that giving residents power to respond to threats could mean that they are dealt with more quickly.

'Buffering' builds capacity to absorb shocks. This could be achieved in Rotterdam via water retention areas in case of flooding, for example. Finally, the principle of 'redundancy', which requires multiple copies of a particular resource or function in case one fails, could be realised through a number of crisis centres or access levels to a building, among other options.

The participants were positive about the concept of resilience and considered it useful for developing climate change adaptation measures. The researchers suggest that resilience principles could help guard against the uncertainties inherent in climate change projections by enhancing a system's ability to cope with a wide range of possible changes in the climate.

Source: Wardekker, J.A. de Jong, A., Knoop, J.M. and van der Sluijs, J.P. (2010). Operationalising a resilience approach to adapting an urban delta to uncertain climate changes. *Technological Forecasting & Social Change*. DOI: 10.1016/j.techfore.2009.11.005.

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Putting a price on the Catalan coastal ecosystems

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Ecosystems in the Catalan coastal system in Spain are worth €2,573 million per year to local citizens, according to new research. By placing a value on ecosystems the research has provided insight into integrated coastal zone management (ICZM) in the area.

"On a per hectare basis, the highest valued service provided by coastal ecosystems was protection against disturbances, such as storms and hurricanes (€62,324 per hectare per year)."

An ecosystems service is the flow of benefits provided by nature to people. Traditionally ecosystems services are not fully incorporated into coastal zone management. However, their economic valuation could help develop emergent EU policy such as the Marine Strategy Framework[1] and the recent protocol on ICZM in the Mediterranean[2].

The study estimated the monetary value of 14 services provided by natural and semi-natural coastal ecosystems in Catalonia and for which no economic markets exist. Services with an existing market value, such as fisheries and agriculture, were not included. Some examples of services valuated are the regulation of freshwater, erosion control, soil formation and atmospheric gas and climate regulation. The monetary values of the services provided by the different types of environment present along the Catalan coast were derived from previous studies and a total value was calculated.

The results indicated that the Catalan coastal systems delivered an economic value of at least €2,572.85 million to citizens in 2004. On a per hectare basis, the highest valued ecosystem service was protection against disturbances, such as storms and hurricanes (€62,324 per hectare per year), and the beach and dune areas provided the highest per unit benefit (€83,820 per hectare per year). However, in terms of total value, temperate forest had the greatest worth because it covered the largest area.

The study also analysed the values of ecosystems geographically. This indicated that the least developed and more natural regions in the northern and southern areas contributed most to the total value of the area. In comparison the ecosystems of the highly populated Barcelona area contributed only 1.2 per cent.

The research provides an economic value for ecosystem services that could help policy makers make informed decisions about land, its conservation, and coastal management. The method and insights could also be applied to research in other coastal areas. However, the researchers point out that, in most cases, a lack of data means that the figures are likely to underestimate the value of ecosystem services. For example, data show that seagrass beds provide a highly valuable service of nutrient cycling, but as there are no data on the other services it provides its total value is relatively small.

Source: Brenner, J., Jiménez, J.A., Sardá, R. & Garola, A. (2010). An assessment of the non-market value of the ecosystem services provided by the Catalan coastal zone, Spain. *Ocean & Coastal Management.* 53: 27-38.

1. See http://ec.europa.eu/environment/water/marine/index_en.htm
2. See http://ec.europa.eu/environment/iczm/barcelona.htm

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Time to take stock of marine and coastal assets

A new study highlights the economic importance of coastal and marine areas and the urgent need to develop concrete methods for assessing their value. Researchers say the need is especially strong now as climate change's impacts could reduce the economic value of coastal and marine environments.

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"Strong methods for valuing marine and coastal environments can help decision makers measure what economies could stand to lose under climate change, and minimise loss."

While it is recognised that marine and coastal environments are important drivers of national economies, they have generally been considered less economically important than their land-based equivalents and some researchers believe that governments have failed to understand their true worth.

Hurricane Katrina in the USA and the devastating Tsunami in Asia in the past few years serve as poignant examples of how coastal damage can have widespread economic impacts. Furthermore, climate change is threatening ocean and coastal economies: sea level rise could damage coastal tourism and ocean acidification is already affecting fish stocks. Strong methods for valuing marine and coastal environments can help decision makers measure what economies could stand to lose under climate change, and minimise loss.

The authors of the new study claim that there is still no appropriate valuation data for decision making in ocean management and an international effort is needed to include ocean valuations in political and planning processes.

Many studies in different countries have already valued ocean economies based on their contribution to national economies – by looking at national accounts data. According to these studies, they contribute between 1.2 and 3.6 per cent of gross domestic product (GDP). However, the researchers point out that the national accounts approach does not consider values that cannot be accounted for in monetary terms, i.e. values for things that are not direct goods or services. For example, the impact of the depletion of fish stocks cannot be considered, because "environmental stocks" are not given a value using this approach. In fact, fisheries can sometimes generate greater monetary value if stocks are depleted as demand drives up prices.

Economists do have ways of estimating the value of environmental assets, such as estuaries, wetlands and mangroves, but these values are often ignored in the decision making process. The researchers say that it is time to prioritise the development of a framework which allows decision makers to account for these values, given the potential impacts of climate change on marine and coastal environments.

Source: Kildow, J.T. and McIlgorm, A. (2010). The importance of estimating the contribution of the oceans to national economies. *Marine Policy*. DOI: 10.1016/j.marpol.2009.08.006.

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Large-scale coastal management more sustainable in the long-term

It is possible to design long-term coastal defence strategies that can be adapted to a range of potential climate change impacts, if prevention measures are considered over larger rather than smaller coastal scales, according to recent research.

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"Management policy based on larger spatial scales appeared to be more sustainable over time and offered more opportunities in the long-term, including benefits for nature and the built environment."

Highly populated, low-lying coastal areas are especially vulnerable to the impacts of climate change. Strategies to defend these zones need to be sustainable and based on a long-term perspective. Such long-term changes in the coastline are likely to be on the scale of tens of kilometres, implying that management policies also need to consider defence strategies at similar scales. However, current adaptation strategies and erosion problems are typically dealt with over smaller scales.

The Netherlands has the most vulnerable coastal zone in the EU. 9 million people live in areas below mean sea level where 70 per cent of the gross domestic product is generated. Inspired by the situation along the central part of the Dutch coast (the Holland coast), the researchers build a case study to explore the effectiveness of alternative coastal management strategies based on different spatial scales (size of areas considered) over a long time span - the next two centuries. The assessment included the impact of climate change, measured in terms of sea level rise and storm surges, on the environment, economy and society.

Current coastal defences along the Holland coast stretch for 118.5 km and consist mainly of sand dunes with some seawalls and sea dikes, designed to safeguard inland areas. Maintenance primarily consists of feeding the dunes with sand to ensure the coastline maintains its present position. This regime was compared with other strategies.

The study concluded that continuing with small-scale management policy would not be the best long-term strategy. Although this policy scored well on technical and financial criteria, other alternatives based on larger spatial scales appeared to be more sustainable over time and offered more opportunities in the long term, including benefits for nature and the built environment.

For example, an intermediate-scale strategy would consider, among other defences, new sand dunes in front of existing dunes to protect inland greenhouse farming and industrial areas. In addition to flood prevention, benefits would include extending the space available for nature and recreation.

The researchers suggest that the uncertainties associated with taking long-term decisions do not prevent the assessment of long-term coastal management strategies: it is possible to develop coastal management strategies that can be adapted to potential climate change impacts over time.

Source: Horstman, E.M., Wijnberg, K.M., Smale, A.J., Hulscher, S.J.M.H. et al. (2009). On the consequences of a long-term perspective for coastal management. *Ocean & Coastal Management*. 52(12): 593-611.

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Geographic Information Systems help manage coastal areas

Geographic Information Systems (GIS) capture and analyse geographic data obtained by methods, such as land surveying, aerial photography and mapping software. A recent study demonstrates the importance and the value of GIS in managing vulnerable coastline.

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"By using GIS to collect data on factors including sea swell, climate, structural conditions and the slope of the coast, it is possible to map potentially unstable areas likely to suffer rock fall from cliffs."

Coastal areas are becoming increasingly vulnerable, especially in the face of climate change. They have a high social, economic and biological value. To take all these elements into account requires integrated management that includes the different organisations involved in coastal management. The researchers believe that GIS can support Integrated Coastal Zone Management (ICZM)[1], an important EU policy which promotes sustainable development.

GIS is increasingly used as a support tool by coastal managers, but a few local authorities still use traditional land management methods, which are much less flexible and cannot consider all the elements involved in coastal management. Different types of coastal zone need different GIS and this study analysed three applications of GIS currently under development in 'littoral' Mediterranean Spanish coastline. The littoral is the area where marine and land processes meet and interact.

GIS can be used to deal with coastal hazards. Degradation of the coast causes rocks to fall from the cliffs of the Catalan coast which is dangerous, particularly during the tourist season. By using GIS to collect data on factors including sea swell, climate, structural conditions and the slope of the coast, it is possible to map potentially unstable areas likely to suffer rock fall. From this 'hazard map' the potential risk can be assessed to put preventive measures in place.

GIS can also help manage shoreline evolution. Environmental conditions and human impacts are changing the position of the shoreline in the Ebro Delta. By acquiring data on the shoreline position from different dates, GIS can determine areas where the coastline is moving backwards or forwards – often known as erosion or accretion. Such analysis has indicated that the area suffering the most erosion is the delta front, especially in the river mouth, where the shoreline has regressed 1650 metres in 50 years. The assessment can contribute to preventative policies for this problem.

Sand dune evolution can also be assessed by GIS. The Ebro Delta is particularly vulnerable to the effects of sea-level rise. If the sea level rises by 0.5 metres, half the delta could be under water which would increase the vulnerability of the dunes to waves. In order to establish protective actions, GIS can collect data on wind transport, swell, sediments and vegetation in the dunes and use it to predict how the dunes would be affected in the short-term and long-term.

In the EU, a major policy development has been the introduction of the INSPIRE Directive[2] in 2007, which establishes an infrastructure for spatial information, such as that provided by GIS, to support European Community environmental policies and activities.

Source: Rodríguez, I., Montoya, I., Sánchez, M.J. & Carreño, F. (2009). Geographic Information Systems applied to Integrated Coastal Zone Management. *Geomorphology*. 107(1-2):100-105.

1. See: http://ec.europa.eu/environment/iczm/home.htm
2. See: http://inspire.jrc.ec.europa.eu/

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A selection of articles on Coastal Management from the *Science for Environment Policy* News Alert

Sinking deltas could increase risk of flooding worldwide (12/11/09)

73 per cent of the world's 33 major river deltas are sinking, according to new research. Results indicate that the sinking is worsened by the impacts of human activity, such as upstream sediment collection caused by reservoirs, dams, accelerated sediment compaction, and control of river channels.

Coastal ecosystems at risk from global loss of seagrass meadows (22/10/09)

Seagrass meadows are declining around the world at an accelerating rate, threatening the health of coastal ecosystems, according to recent research.

Managing the twin risks of flooding and erosion in coastal areas (10/9/09)

Coastal areas are naturally at risk from erosion and flooding, but this risk is increased by the effects of climate change. A recent study has examined choices for regulators and coastline managers and suggests that successful management in high risk areas needs a fully integrated approach involving all stakeholders.

Sea level rise of 3.3 metres from West Antarctic Ice Sheet collapse (31/7/09)

The West Antarctic Ice Sheet (WAIS) is vulnerable to even moderate climate change and could collapse rapidly, pushing up sea levels around the world. A new study concludes that the global sea level rise (SLR) from the collapse of the WAIS will not be as high as predicted by previous studies, but still substantial at around 3.3 metres on average.

Jellyfish infestations caused by human activities (31/7/09)

A huge rise in jellyfish populations around the world appears to be caused by human activities, according to recent research. Early action is essential to prevent marine ecosystems from changing to unhealthy states that favour destructive jellyfish blooms.

Sea levels to rise by one metre in the next 100 years? (5/3/09)

Rising sea levels will have dramatic consequences for many coastal areas around the world. A new study suggests that over the next 100 years, sea levels could rise to a metre higher than current levels, a rate faster than at any time during the past 2000 years.

To view any of these articles in full, please visit: http://ec.europa.eu/environment/integration/research/newsalert/index_en.htm, and search according to article publication date.